

SAN ANDREAS FAULT MONITORING AT PARKFIELD

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RESEARCH OBJECTIVES

Since 1987, a special network of 10 borehole seismographs has operated at Parkfield, Calif., as part of the U.S. Geological Survey-directed earthquake prediction experiment underway there. The purpose of the network is to provide data on the occurrence of earthquakes as small as magnitude 1.0 for improving our understanding of fault-zone dynamics. Of particular importance is the role of the network in providing a roadmap of the microearthquake population for the SAFOD (San Andreas Fault Observatory at Depth) deep drilling project to be conducted at Parkfield.

APPROACH

The network is designed to be able to detect and locate precisely the smallest earthquakes possible, a result of the extremely low background noise and attenuation found at the sensor depths of 200-300 meters. For the deep drilling project, we are adding three new sensors in boreholes near the planned intersection at 3-4 km depth on the active fault surface. Installation, operation, maintenance and much of the data reduction has been accomplished through joint efforts of campus and LBNL personnel.

ACCOMPLISHMENTS

Analyses of the 12+ years of monitoring data have revealed significant and unambiguous departures from stationarity both in the seismicity characteristics and in wave propagation details. A high V_p/V_s anomaly exists at depth. Synchronous changes well above noise levels have been seen among several independent parameters, including seismicity rates, average focal depth, S-wave coda velocities, characteristic sequence recurrence intervals, fault creep and water levels in monitoring wells. Scaling laws have been developed from the Parkfield earthquakes that can be projected to fit earthquakes up to M6, and they predict unprecedented high stress drops and melting on the fault surface for the smallest events. Recurrence interval variations in the characteristic event sequences (>60% of the microearthquake population) have been used to map fault slip rate at depth on the fault surface. We have challenged the conventional "constant stress drop" source model, affirmed characteristic earthquake occurrence and developed four-dimensional maps of fault-zone microearthquake processes at the unprecedented scale of a few meters. This unique body of new observations and data analyses has provided much of the impetus for Parkfield as the preferred site for deep drilling into an active seismogenic fault zone - a concept that has become the large national initiative SAFOD.

SIGNIFICANCE OF FINDINGS

The significance of these findings lies in their apparent coupling and interrelationships, from which models for fault-zone process can be fabricated and tested with time. The more general significance of the project is its production of a truly unique continuous baseline, at very high resolution, of both the microearthquake pathology and the subtle changes in wave propagation, providing to the seismological community an earthquake laboratory available nowhere else.

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